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Kim et al.

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(54) **EXPLOSIVELY DRIVEN IMPACTOR GRENADE**

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(52) **U.S. Cl.** **102/482**; 102/307; 102/383; 102/476; 102/480; 102/487; 86/50

(58) **Field of Search** 102/306–310, 102/383, 476, 480, 482, 487, 488, 489; 86/50

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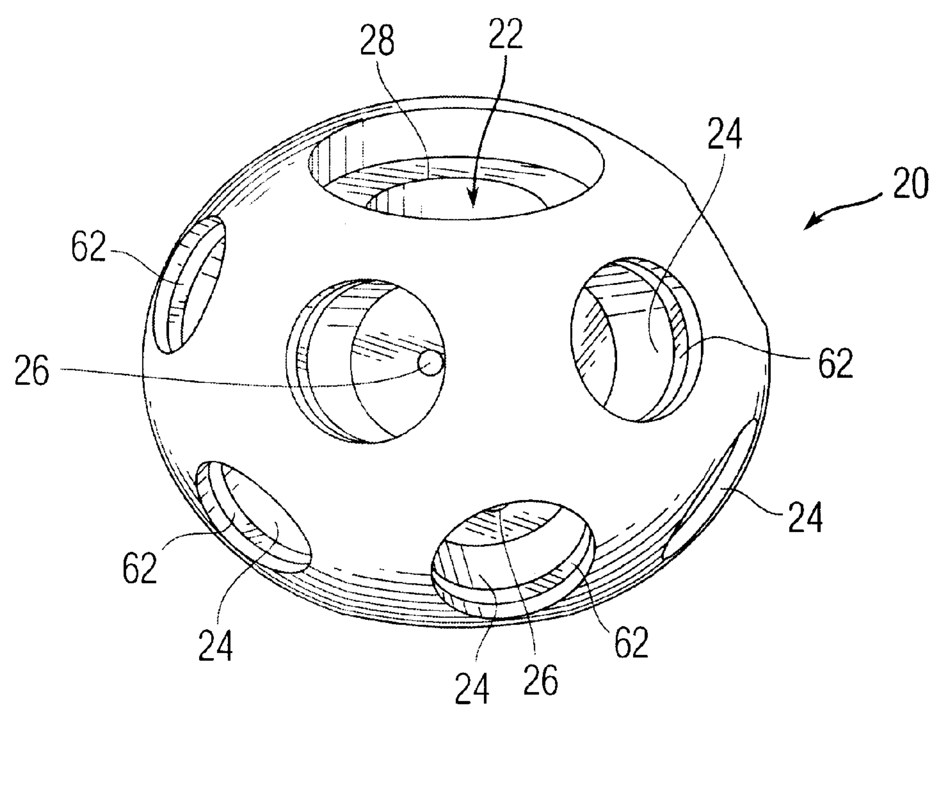
(57) **ABSTRACT**

An explosively driven impactor grenade includes a grenade body having a substantially spherical shape and a hollow central portion, the grenade body including a plurality of recesses formed on an external surface thereof with each recess including an opening into the hollow central portion of the grenade body, the grenade body including an opening on the exterior surface that connects with the hollow central portion; a fuze disposed in the hollow central portion of the grenade body; a fuze cap for closing the opening on the exterior surface that connects with the hollow central portion; and a plurality of explosively driven impactors respectively disposed in the plurality of recesses formed on the external surface of the grenade body, the explosively driven impactors being connected to the fuze through the recess openings into the hollow central portion of the grenade body.

19 Claims, 2 Drawing Sheets



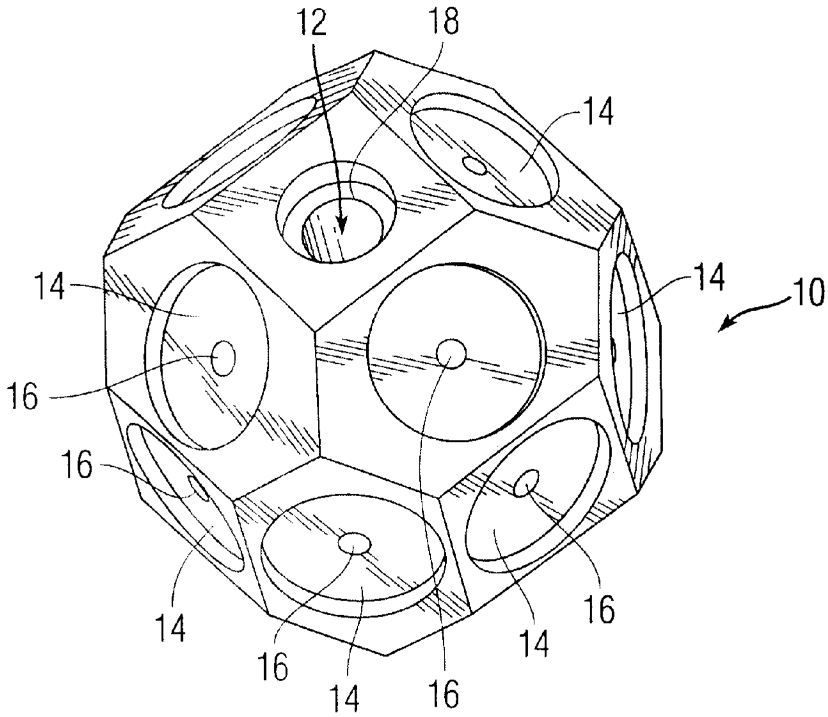

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Fig. 1

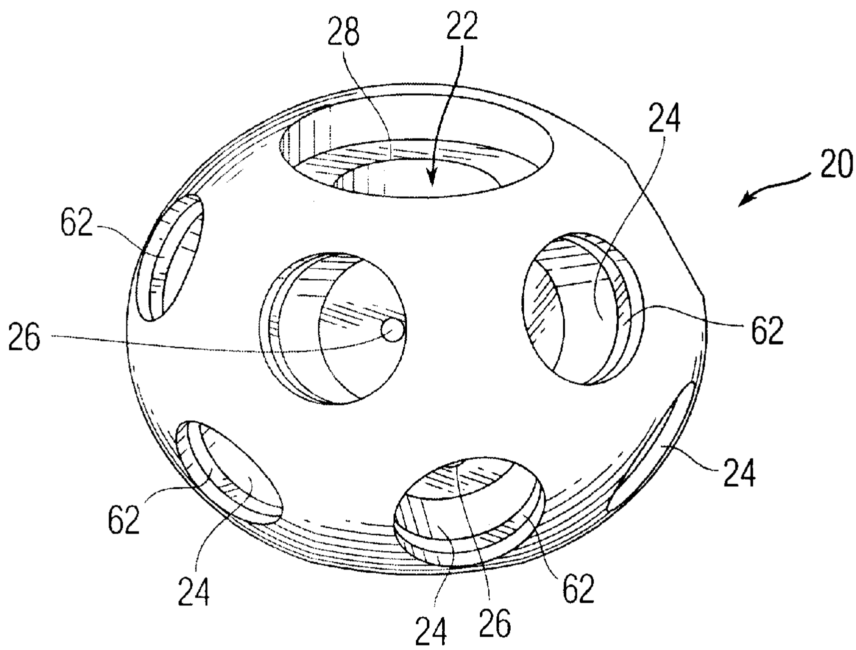
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Fig. 2

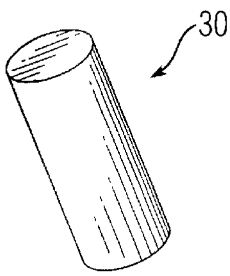

Fig. 3A

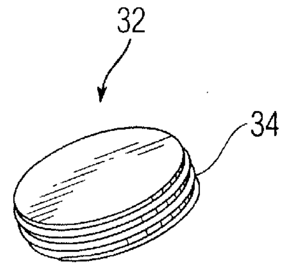

Fig. 3B

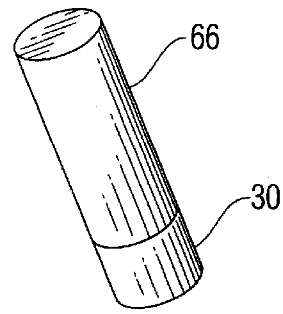

Fig. 6

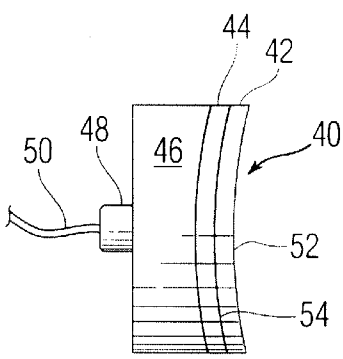

Fig. 4

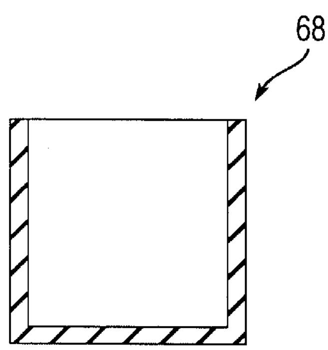

Fig. 4A

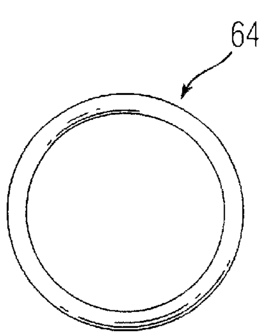

Fig. 5A

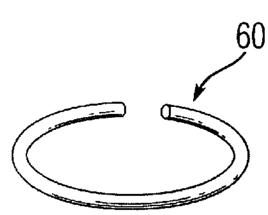

Fig. 5

EXPLOSIVELY DRIVEN IMPACTOR GRENADE

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of the United States of America for government purposes without the payment of any royalties therefor.

BACKGROUND OF THE INVENTION

The invention relates in general to grenade type munitions and in particular to a grenade type munition comprising Explosively Driven Impactors (EDIs).

A need exists for a biological and chemical agent defeat warhead. The warhead would enable the attack of chemical and biological agents located within semi-hardened or hardened storage and manufacturing facilities. The warhead would be delivered by a precision air, ship or submarine weapon system, with minimum collateral damage to the surrounding area. To destroy biological and chemical agents, the agents must first be released from their containers. The EDI grenades are designed to rupture containers to release the chemical and/or biological agent contents with minimal collateral damage due to low overpressure from the grenades. Once the agents are released, the Agent Defeat High Temperature Thermal Radiator (HTTR) payload will destroy the agents. The EDI grenade can also be used by individual soldiers as a hand grenade.

The EDI grenades for agent defeat application are thermally fuzed to operate when a pre-determined room temperature is reached. The thermal fuzing is required for agent defeat application because to minimize collateral damage, the room temperature needs to be high enough to create a lethal environment for biological agents before the agent containers are ruptured. The EDI grenades can be alternatively fuzed for other applications such as for anti-personnel. Other fuzing methods for an EDI grenade include time delay, pressure sensing and impact fuzing.

If existing grenades such as the M67, M61 or MK3A2 were used for agent defeat application, the collateral damage would be much higher due to its greater over-pressure characteristic. These hand grenades do not have the penetration capability of an EDI grenade.

The invention will be better understood, and further objects, features, and advantages thereof will become more apparent from the following description of the preferred embodiments, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, which are not necessarily to scale, like or corresponding parts are denoted by like or corresponding reference numerals.

FIG. **1** is a perspective view of a one embodiment of a grenade body.

FIG. **2** is a perspective view of a second embodiment of a grenade body.

FIG. **3**A schematically shows a fuze and FIG. **3**B shows a fuze cap.

FIG. **4** is a side view of an explosively driven impactor.

FIG. **4**A is a sectional view of a cup for housing an explosively driven impactor.

FIG. **5** shows a retaining ring.

FIG. **5**A shows a gasket.

FIG. **6** schematically shows a fuze and a booster charge.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The purpose of the Explosively Driven Impactors (EDI) grenade is to cause damage to equipment, storage containers, and personnel. In one scenario, the EDI grenade ruptures containers filled with biological or chemical agents with minimal collateral damage effects due to its low overall overpressure output. The EDI grenade is unique because of the use of EDIs. This application of EDI technology inflicts multi-directional damage, possesses greater penetration capability than existing hand grenades and eliminates the need for a self-righting mechanism.

The EDI grenade includes a grenade body having a substantially spherical shape. For the purposes of this patent, a substantially spherical shape includes spherical, flattened spherical and geodesic shapes. The importance of the substantially spherical shape of the grenade body is that it allows the EDI grenade to be multi-directional no matter how it finally comes to rest. In this regard, a self-righting mechanism is not required. For example, in agent defeat applications, the EDI grenade can affect storage containers regardless if it lands next to or on top of a container and regardless of its landing orientation. The grenade body material may be metallic (steel, aluminum, etc.) or plastic. The diameter of the grenade body may vary from, for example, two inches to thirty-six inches.

FIG. **1** is a perspective view of a one embodiment of a grenade body **10**. Grenade body **10** has a geodesic shape. Grenade body **10** includes a hollow central portion **12** for receiving a fuze. The exterior surface of the body **10** includes a plurality of recesses **14** formed thereon for receiving the EDIs. Each recess **14** includes an opening **16** into the hollow central portion **12** of the grenade body **10** to allow deflagration cord to connect the EDIs with the fuze. The grenade body **10** also includes an opening **18** on the exterior surface for insertion of the fuze. The opening **18** connects with the hollow central portion **12**

FIG. **2** is a perspective view of a second embodiment of a grenade body **20**. Grenade body **20** has a flattened spherical shape. Grenade body **20** includes a hollow central portion **22** for receiving a fuze. The exterior surface of the body **20** includes a plurality of recesses **24** formed thereon for receiving the EDIs. Each recess **24** includes an opening **26** into the hollow central portion **22** of the grenade body **20** to allow deflagration cord to connect the EDIs with the fuze. The grenade body **20** also includes an opening **28** on the exterior surface for insertion of the fuze. The opening **28** connects with the hollow central portion **22**.

FIG. **3**A schematically shows a fuze **30**. Fuze **30** is disposed in the hollow central portion **12** of the grenade body **10** or the hollow central portion **22** of the grenade body **20**. The EDI grenade contains a single fuze **30**. Fuzing methods include thermal, time delay, pressure sensing and impact, depending upon the application. The EDIs (FIG. **4**) are all connected to this common fuze **30** so that the EDIs will all initiate at the same time. FIG. **3**B shows a fuze cap **32** for closing the openings **18**, **28** on the exterior surface that connects with the hollow central portions **12**, **22**. The fuze cap **32** may include threads **34** that mate with threads on the interior of openings **18**, **28**.

FIG. **4** is a side view of an explosively driven impactor (EDI) **40**. EDI **40** includes a circular metal disk **42**, a backing layer **44**, high explosive **46**, an ignition device **48** and deflagration cord **50**. The EDI **40** fits in the recesses **14, 24** in the grenade bodies **10, 20** with the circular metal disk **42** facing outward. The deflagration cord **50** is fed through the openings **16, 26** in the recesses **14, 24**. All the cords **50** are joined together and then attached to fuze **30** so that all the EDIs will actuate at the same time.

Circular metal plate **42** is preferably concave on its side **52**, that is, the side that faces away from the grenade body. The internal side of plate **42** is preferably convex. A preferred metal for plate **42** is copper. The thickness of plate **42** is, for example, from about 0.07 inches to about 0.125 inches. The plate thickness depends on the plate diameter and the target thickness desired to be penetrated. The plate **42** is pressed formed into its curved shape. Copper is easily formed into different shapes. The recesses **14, 24** are deep enough so that the EDIs **40** do not extend further outward than the adjacent exterior surface of the body **10, 20**.

Behind plate **42** is a backing layer **44** comprising an elastomer such as solid rubber (i.e., not foam rubber). The backing layer **44** is attached to plate **42** with adhesive. The high explosive **46** may be molded into shape or pressed into recesses **14, 24**. If the explosive **46** is molded, it is adhered into the recesses **14, 24** with an adhesive compatible with the explosive **46**. The explosive **46** is preferably a Class 1.1 High explosive such as C4 or HMX. The plates **42** with backing layer **44** attached are dropped into the recesses **14, 24** on top of the explosive **46**. Plate **42** is secured with a retaining ring **60** (See FIG. **5**). There is a groove **62** along the circumference of each recess **24** (See FIG. **2**) to accept the retaining ring **60**. The backing layer **44** is slightly compressed during the retaining ring installation to take up any volume between the backing layer **44** and the explosive **46**.

Prior to installing the explosive **46** and plate **42**, an ignition device **48** is installed into each recess **14, 24**. The ignition device **48** has a small amount of energetic material, such as Boron Potassium Nitrate, in a metallic housing to initiate the explosive **46**. Deflagration cords **50** are attached to each ignition device **48**. After the ignition devices **48** are all installed and the deflagrating cords **50** are fed out of each recess **14, 24** and into the fuze hole **12, 22**, the explosives **46** and plates **42** are installed. After the explosives and plates are installed the deflagrating cords **50** are connected together and joined to a single fuze **30**. The fuze is then installed into by way of opening **18, 28** into the hollow central portion or fuze hole **12, 22**. A fuze cap **32** is preferably threaded to cover the opening **18, 28**. If a time delay fuze is used (such as those used in hand grenades) there will be a pull pin through the cap **32**. When the pull pin is pulled, the fuze is activated.

The metal plates **42** undergo a controlled acceleration when the explosive **46** is initiated. The EDI performance characteristics are tailored to meet the required flight distance and target strength. The EDIs **40** are substantially evenly patterned on the grenade body surface. The EDIs **40** are simultaneously initiated when the fuze **30** senses a specific environmental temperature (if the fuze is a thermal fuze). In the agent defeat application, the EDIs are initiated by a thermal fuze when the HTTR reaction drives the temperature in the target area to 250–500° F. Dependent upon the target penetration requirement, the weight ratio of plate **42** to high explosive **46** can be less or greater than one to two.

The grenade disperses the EDIs **40** in multiple directions at a variety of target configurations and at a large velocity range. During dispersal, the grenade can interact with a variety of stationary objects. The body structure is designed to withstand high acceleration loads and high velocity impacts. The orientation of the grenade can vary depending on launch/dispersal velocities and impact angles. Therefore, the grenade body contour is designed with a self-righting shape. At rest, the grenade will position itself in a predefined orientation. This orientation will aim a predefined number of EDIs **40** in a repeatable direction with respect to the ground surface.

Upon detonation, the plates **42** are dispersed at velocities great enough to create holes in metal targets such as steel containers. The penetration ability of even a small EDI is substantial. For example, a 2-inch diameter EDI can create a hole in 1-inch thick armor plate. The size of the EDI grenade will depend upon the size of the EDI utilized. The EDIs employed in the grenade have greater penetration capability against armored targets than existing hand thrown grenades such as the anti-personnel M67 and M61 hand grenades. Depending upon the size of the individual EDI, the EDI can penetrate several inches of metal armor.

Some advantages of the EDI grenade include:

1) Incorporating a number of EDIs into a single grenade to effect a much greater level of damage against equipment and personnel than a single EDI.

2) Minimal collateral damage effects to the surrounding area due to the low-overpressure characteristic of the EDI grenade. For example, if the target were a container filled with weaponized Anthrax spores, the lower-overpressure generated by the EDI grenade would minimize dispersal of the Anthrax spores. This is due to the smaller amount of high explosives required for the EDI operation than that required for hand grenades of comparable size.

3) The EDI grenade is multi-directional. A self-righting mechanism is not required. For example, in agent defeat applications, the EDI grenade can affect storage containers regardless if it lands next to or on top of a container and regardless of its landing orientation.

In an alternative embodiment of the invention, each explosively driven impactor comprises a metal plate **42**, a backing layer **44** and an explosive **46**. The explosive **46**, backing layer **44** and metal plate **42** are contained in a metal housing **68** in the shape of a cup (FIG. **4A**). The metal housing **68** is open at the top so that the metal plate **42** is free to launch. The metal housing **68** is made of, for example, aluminum having a thickness of about 0.02 inches. The ignition devices **48** are not used in this embodiment.

The explosive **46**, backing layer **44** and metal plate **42** are placed in housings **68**. Housings **68** are then placed in recesses **14, 24**. An elastomeric gasket **64** (FIG. **5A**) is placed atop the housing **62**. The retaining ring **60** is then placed in groove **62**. The elastomeric gasket **64** between the top of housing **68** and retaining ring **60** takes up any assembly gaps and compensates for thermal dimensional changes.

In this alternative embodiment, a booster charge **66** (FIG. **6**) is placed in the hollow central portions **12, 22** of the body **10, 20**, along with fuze **30**. Fuze **30** initiates booster charge **66** which initiates the explosive **46** in the individual EDIs. A physical connection (deflagration cord) between the booster charge **66** and the explosive **46** is not needed, but may be used if desired. The booster charge **66** is near enough to explosive **46** to initiate explosive **46** without deflagration cord. Booster charge **66** comprises, for example, a high explosive.

While the invention has been described with reference to certain preferred embodiments, numerous changes, alterations and modifications to the described embodiments are possible without departing from the spirit and scope of the invention as defined in the appended claims, and equivalents thereof.

What is claimed is:

1. An EDI grenade, comprising:

a grenade body having a substantially spherical shape and a hollow central portion, the grenade body including a plurality of recesses formed on an external surface thereof with each recess including an opening into the hollow central portion of the grenade body, the grenade body including an opening on the exterior surface that connects with the hollow central portion;

a fuze disposed in the hollow central portion of the grenade body;

a fuze cap for closing the opening on the exterior surface that connects with the hollow central portion; and

a plurality of explosively driven impactors, each explosively driven impactor comprises a circular metal plate, a backing layer, an explosive, an ignition device and a cord, the cord being connected to the fuze, respectively disposed in the plurality of recesses formed on the external surface of the grenade body, the explosively driven impactors being connected to the fuze through the recess openings into the hollow central portion of the grenade body.

2. The EDI grenade of claim **1** wherein the plurality of recesses formed on the external surface of the grenade body are substantially evenly distributed over the external surface of the grenade body.

3. The EDI grenade of claim **1** wherein the grenade body comprises one of metal and plastic.

4. The EDI grenade of claim **1** wherein the fuze is one of thermal, time delay, pressure sensing and impact.

5. The EDI grenade of claim **4** wherein the fuze is thermal and is activated in the range of 250 to 500 degrees Fahrenheit.

6. The EDI grenade of claim **1** wherein the shape of the grenade body is geodesic.

7. The EDI grenade of claim **1** wherein the shape of the grenade body is flattened spherical.

8. The EDI grenade of claim **1** wherein a diameter of the grenade body ranges from about two inches to about thirty-six inches.

9. The EDI grenade of claim **1** wherein said cords comprise deflagration cords.

10. The EDI grenade of claim **9** wherein the circular metal plate comprises copper.

11. The EDI grenade of claim **9** wherein the circular metal plate comprises a concave external surface and a convex internal surface.

12. The EDI grenade of claim **9** wherein the backing layer comprises an elastomer.

13. The EDI grenade of claim **12** wherein the elastomer comprises hard rubber.

14. The EDI grenade of claim **9** wherein a thickness of the circular metal plate is in the range of about 0.07 inches to about 0.125 inches.

15. The EDI grenade of claim **9** wherein the explosive is c4 or HMX.

16. The EDI grenade of claim **1** wherein each recess includes a circumferential groove formed therein, the EDI grenade further comprising retaining rings disposed in the circumferential grooves atop each EDI.

17. An EDI grenade, comprising:

a grenade body having a substantially spherical shape and a hollow central portion, the grenade body including a plurality of recesses formed on an external surface thereof with each recess including an opening into the hollow central portion of the grenade body, the grenade body including an opening on the exterior surface that connects with the hollow central portion;

a fuze and a booster charge disposed in the hollow central portion of the grenade body;

a fuze cap for closing the opening on the exterior surface that connects with the hollow central portion; and

a plurality of explosively driven impactors, each explosively driven impactor comprises a circular metal plate, a backing layer, an explosive and a cup-shaped metal housing containing the circular metal plate, backing layer and explosive, respectively disposed in the plurality of recesses formed on the external surface of the grenade body; wherein

the fuze initiates the booster charge which initiates the explosively driven impactors.

18. The EDI grenade of claim **17** wherein each recess includes a circumferential groove formed therein, the EDI grenade further comprising an elastomeric gasket placed atop each explosively driven impactor and a retaining ring disposed in the circumferential groove atop each elastomeric gasket.

19. The EDI grenade of claim **17** wherein the plurality of recesses formed on the external surface of the grenade body are substantially evenly distributed over the external surface of the grenade body.

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